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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

SEPTEMBER 4, 1989

NINE NEW MAVERICKS

We pick the semiconductor fraternity of the '90s

PAGE 30

Japanese covet workstation partners PAGE 17

Board makers fight for profits PAGE 83

Electronic Business

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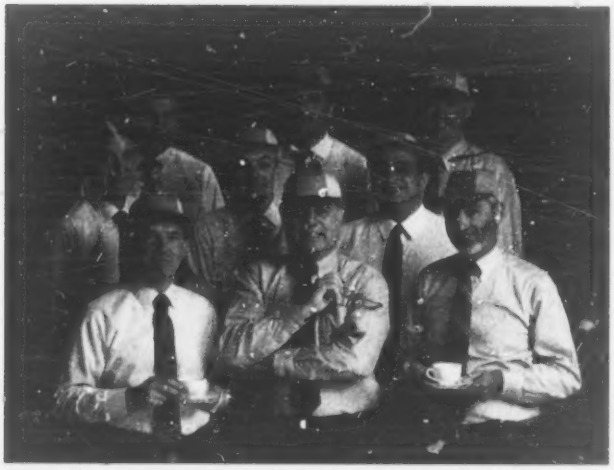
VOL. 15, NO. 18 SEPTEMBER 4, 1989



PAGE 30 Nine new mavericks: bottom row, left to right, Dan Hauer, S-MOS Systems; Michael Hackworth, Cirrus Logic; James Diller, Sierra Semiconductor; center row, Bernard Vonderschmitt, Xilinx; Vin Prothro, Dallas Semiconductor; Thomas Longo, Performance Semiconductor; top row, John Gifford, Maxim Integrated Products; George Perlegos, Atmel, and James Bixby, Brooktree.

COVER STORY/STRATEGIES

30 Nine new mavericks: Semiconductor stars of the '90s

Two years ago, ELECTRONIC BUSINESS singled out 10 ingenious semiconductor start-up companies that were models of success. Two years have shown that such a maverick approach is winning as these companies are all profitable and growing. This year, we select and introduce nine new start-ups just as successful and just as unorthodox — and just as willing to break all the rules.

BUSINESS TRENDS

17 Japan partners its way into elusive workstation arena

If you can't beat 'em, join 'em. That's the strategy being pursued by cash-rich Japanese companies seeking to increase their lean 17% share of a rapidly growing $4.3 billion workstation market. Once there were expectations that the Japanese would play big in workstations on their own; now the thrust is to invest in U.S. manufacturers.

23 "Lightsat" contractors maneuver to meet demand

The U.S. Department of Defense has concluded that reliance on a few large, sophisticated satellites could prove fatal during war — prompting a flurry of activity aimed at developing so-called "lightsats" and creating a potential $100 million for light satellites by the early 1990s.

STRATEGIES

30 Nine new mavericks: Semiconductor stars of the '90s

1983 and 1984. They were the boom years. Years that heralded the worst semiconductor downturn in history. But they actually were a great time to start a chip company. Some of today's hottest companies were founded — some 70 of them. As our picks for the nine semiconductor success stories of 1989 attest, these new companies are a breed apart from the humdrum, standard-offering "me-too" chip company.

36 Where are they now: 1987's superstars revisited

Two years ago, 10 maverick start-up companies began to change the way semiconductor business was done. These Silicon Valley firms were content to throw traditional chip wisdom to the wind: they focused on niche markets, in some cases didn't build fabs, and vowed to control their costs. A revisit in 1989 shows that these companies' unconventional strategies are reaping dividends. Their big challenge now is to keep their entrepreneurial flames burning.

44 The Law of the Microcosm

In this second of two excerpts from George Gilder's book on the semiconductor industry, *Microcosm*, Gilder explains his theory of the microcosm — that economics and politics have taken their cue from the overthrow of matter in modern physics. The microchip, Gilder argues, epitomizes the microcosm. In this installment, Gilder argues that the law of the microcosm favors the emergence of small entrepreneurs.

MANAGING RESOURCES

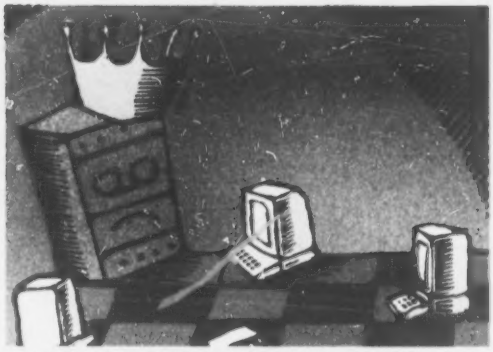
55 Merging engineering skills that give you the edge

In the sixth article in a continuing series, McKinsey & Co. says many companies seeking the benefits of so-called simultaneous engineering have tried to integrate manufacturing and product engineering by having these functions report to the same person. But that fix does not go far enough. To be effective, integration has to take place at lower levels in a company.

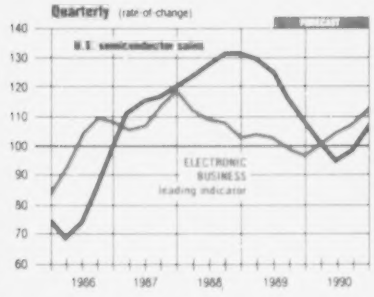
Cover photograph Christopher Springmann

PAGE 63 T. Rowe Price's Roger B. McNamee: "Right now it is a seller's market in DRAMs"

PAGE 79 Winbend's Yang Ding-yuan: "Semiconductors are the core of the [Taiwan] information production industry"



PAGE 44 George Gilder's The Law of the Microcosm, the second of two excerpts from *Microcosm*



PAGE 93 Business Barometer: Consensus continues, no full-fledged recession

PAGE 17 Sony Microsystems' Tom Steding: Targeting niche workstation markets

PAGE 11 Simtek's Richard Petritz: New twists for nonvolatile memory chips

EUROPE BUSINESS

74 European ASIC makers seek home-field advantage

Lured by a healthy home market for application-specific integrated circuits, European semiconductor manufacturers are mired in a struggle to expand their market share on the continent. But the challenge they face may be too much to withstand. A host of hostile conditions, including cutthroat competition from the United States and Japan, present formidable obstacles.

63 DRAM futures trading: High tech not yet sold

Plans are afoot to begin DRAM futures trading by the middle of next year on at least two commodities exchanges. The goal is to tame price volatility in the sprawling semiconductor memory market. While the plans still are being sorted out by the electronics industry, some executives are backing the concept as a boon to companies that use DRAMs in large quantities.

ASIA/PACIFIC BUSINESS

79 Burgeoning IC production bolsters Taiwan electronics

Taiwan has been the home of the cheap windup toy, the souvenir salt and pepper shakers, and the glow-in-the-dark Frisbee. But now, that nation is home to a burgeoning semiconductor industry as well. Spurred on by the government, the hope is that increased IC production will thrust the island into the big leagues of high technology.

MARKET PERSPECTIVES

83 Board makers fight for profits as growth slows

Despite healthy growth in the U.S. printed wiring board industry — the market grew 17% in 1988 to $5.5 billion — profits have been scarce. Adding to the crunch are demands for higher density packaging, improved quality and faster turnaround. To meet the stepped-up requirements, independent PCB manufacturers have been forced to invest heavily in new capital equipment.

BUSINESS BAROMETER

93 Economic outlook

The word recession may be more popular than ever these days, but Cahners Economics says there will be no full-fledged recession in the next year.

94 Leading indicator

The ELECTRONIC BUSINESS Leading Indicator dropped to 103.2 in May and is expected to fall to 95.7 in October.

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Chip-making mavericks

Editor Bairstow (far left), with bureau chief Rice (right), assistant editor McCreadie (upper far left), and the nine new mavericks.

Being different takes guts sometimes. After all, the status quo is always easier to maintain. The nine fast-growing semiconductor companies we are featuring in this issue — and the 10 we are revisiting from two years ago — have formed strategies much different from the typical well-established chip company. Our West Coast bureau manager Valerie Rice and assistant editor John McCreadie show how these maverick small companies have gone against the grain of humdrum semiconductor industry wisdom — opting for niche markets, forging strategic alliances and carefully eyeballing costs. It works, our writers say; witness these brash companies, all profitable and growing.

So if these upstart companies can be unorthodox in their approaches, why can't we do the same once in a while? Yes, those are indeed propeller beanies on the heads of the chief executives of the companies we selected as the new semiconductor success stories. We could have run your standard annual-report-type group photograph, but we say, Why not do it differently, like the new breed does? That's the way they would have done it, I'm sure.

Besides, what's good for them is also good for us. In the photograph that accompanies this column, that's a beanied editor Jeff Bairstow on the far left, with the nine executives and Rice at the right and McCreadie at the upper far left.

The idea for the beanies belongs to free-lance photographer Chris Springmann, a frequent contributor to ELECTRONIC BUSINESS. We think it is a great departure. Again, these semiconductor executives are building their futures on taking chances.

They even took their beanies home with them.

MARVIN GREENE, section editor

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VBPA ABP

Nine new mavericks

We pick the semiconductor fraternity of the '90s

Two years ago, ELECTRONIC BUSINESS *singled out 10 semiconductor start-up companies that were models of success. These weren't the typical "me-too" chip companies, but a new breed who were making their own rules. Two years have shown that such a maverick approach is winning. This year, we select and introduce nine new start-ups — just as successful and just as unorthodox. And we look back to the maturing upstarts of 1987, challenged today to maintain the entrepreneurial spirit.*

BY JOHN McCREADIE and VALERIE RICE

There's a new breed of chip makers taking hold of the semiconductor world — ingenious, niche-driven start-ups quick to abandon the old rules. Nine of them best illustrate why these new generation qualities are winning

There was something magical about those years.

They were the boom years of 1983 and 1984 — years that heralded the worst semiconductor downturn in history, but actually were a great time to start a chip company.

Some of today's hottest companies were founded during this period, the most fertile in semiconductor history. Market research firm Dataquest Inc. estimates that 70 companies were formed during this two-year period.

But these new companies were a breed apart. Gone was the old humdrum, standard-offering "me-too" chip company. In its place were vital, energetic firms determined not to make the same mistakes as their predecessors. There's no overspending and under marketing here. And if these maverick chip makers had to abandon old rules, create new ones or just plain do without rules altogether, then so be it.

Nine chip makers, all currently profitable and growing, best illustrate such new generation qualities: Atmel Corp., Brooktree Corp., Cirrus Logic Inc., Dallas Semiconductor Corp., Maxim Integrated Products, Performance Semiconductor Corp., Sierra Semiconductor Corp., S-MOS Systems Inc. and Xilinx Inc.

These companies all had sales of less than $100 million in calendar 1988, and their leaders are experienced, street-smart executives savvy to the realities of the semiconductor business. Five of these companies don't even have their own fabs.

But being a maturing start-up is not easy, particularly in an era of declining demand, cautious buyers and megabucks competitors. As these new-breed companies head for the 1990s, they can expect stiffer competition. From hands-on management and niche marketing to strategic alliances and plain old sweat of the brow, these companies are gambling their futures that they will be the next to hit it big.

Up or down business

"The [semiconductor] battlefield is scattered with guys who just stepped a little bit on a mine," says John F. Gifford, president of six-year-old Maxim of Sunnyvale, Calif. "The most scary part of the high-tech business is there is no level ground —it's

Christopher Springmann

Our hats are off, too, to these successful semiconductor start-ups. ELECTRONIC BUSINESS found nine maturing companies headed for stardom. Their leaders are, bottom row, from left to right: Dan Hauer, S-MOS Systems; Michael Hackworth, Cirrus Logic; James Diller, Sierra Semiconductor; center row, Bernard Vonderschmitt, Xilinx; Vin Prothro, Dallas Semiconductor; Thomas Longo, Performance Semiconductor; top row, John Gifford, Maxim Integrated Products; George Perlegos, Atmel, and James Bixby, Brooktree

up or it's down." Some recent minefield victims include Laserpath Corp. and Telmos Inc., according to a Dataquest survey.

But for these nine companies, the prospects are bright. More than ever, blue-chip companies such as Digital Equipment Corp. and Unisys Corp. are making volume deals with start-ups. Performance Semiconductor and Xilinx are two examples of beneficiaries. And as the industry moves into a recession brought on by contracting demand, those with the leading-edge technology will continue to win those contracts.

"Within large organizations there's been a tendency in the past to dissuade people from doing business with small start-up companies," says Richard A. Cowgill, Unisys' engineering department manager in the systems development organization. "The fact that technology is changing so rapidly today and with the cost of custom ICs — it behooves us to look at these guys."

And even technology-averse Wall Street is giving these independent-minded start-ups their due. "They have all found something different to exploit, some unique angle," explains Donaldson, Lufkin & Jenrette Securities Corp. analyst Drew Peck. "There is a value added there."

If there is a primary reason these companies are as hot as they are today, then the key may be their management strategies. Tossing aside the textbook has taught executives in these firms some hard lessons. "I learn much more from disasters than from successes," explains Dallas Semiconductor's president and CEO Vin Prothro, referring to his management style.

During his 12 years at Mostek Corp., the DRAM shortage was one disaster that taught Prothro to "always work on new products." He says, "You can't survive such shortages with only one product." Dallas Semiconductor reported revenue of $58 million in 1988, and analysts predict the company will finish 1989 with about $85 million.

Experience is a common thread among most of these executives. Gifford of Maxim has been involved in six different start-ups in his 25-year career — including Advanced Micro Devices Inc. "Ninety-five percent of everything in this business I've seen before," he boasts. And experience has shown Performance Semiconductor president Thomas A. Longo, a veteran of Fairchild Semiconductor Corp., that forming a start-up is a breeze compared with starting a division within a large company, "because there are more interferences in a large company."

This management experience has facilitated changes in the way semiconductor firms traditionally operate. Employees in these unconventional companies are rewarded with such perks as ownership, which is generally absent in larger firms. Atmel workers own 60% of their company, Maxim's, 38%.

No overspenders

Even though the new-breed chip makers are more image conscious than their forerunners, overspending doesn't pose a significant problem; they remain thrifty on purchases they feel don't matter, such as office facilities or furniture. "It took me 15 months to get a chair with wheels," Atmel's vice president for sales Jack Peckham says wryly.

And this austerity is paying off. The new breed is reinvesting a healthy average of 17% of their sales into research and development of future products, outstripping the industry's 11% average, which is calculated by the Semiconductor Industry Association. In addition, these companies have cash in the bank, ranging from Performance Semiconductor's $8 million to Dallas Semiconductor's $40 million. And all show strong revenue-per-employee figures from $128,000 at Maxim to $1 million at S-MOS, whose incredibly high figure reflects one advantage of not doing its own manufacturing — fewer employees.

One significant outcome of all this R&D spending is greatly reduced product development leadtimes. Leadtimes that were two years or longer several years ago have been cut to one year or less, these aggressive start-ups claim. "We've shortened our product development cycle times to around nine months," says Cirrus Logic's president Michael Hackworth.

Pace of funding start-ups is slowing

Start-up semiconductor companies still are thriving, but the pace is slowing.

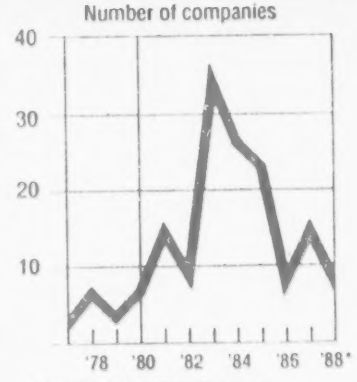
In the 10 years between 1977 and 1987, market research firm Dataquest Inc. estimates that 157 companies were started. And during the halcyon years of 1983-84, a record 70 semiconductor companies were formed. But in 1988, according to Venture Economics Inc. data, only 11 start-up semiconductor companies received funding for the first time that year; this figure does not include privately funded companies. By comparison, Dataquest research tracked 15 start-ups formed in 1987.

Venture capital funding is decreasing as well. According to Venture Economics, a research and consulting firm, chip vendors raised $115 million in venture money in 1988, down from $149 million in 1987. The number of financing rounds also fell, from 57 in 1987 to 45 in 1988.

Semiconductor companies represent a larger share of technology funding as a whole — up to 33% of the total number of financings in 1988, despite the total dollar value for the electronics industry falling last year to $259 million from $350 million in 1987.

VALERIE RICE

Semiconductor start-ups

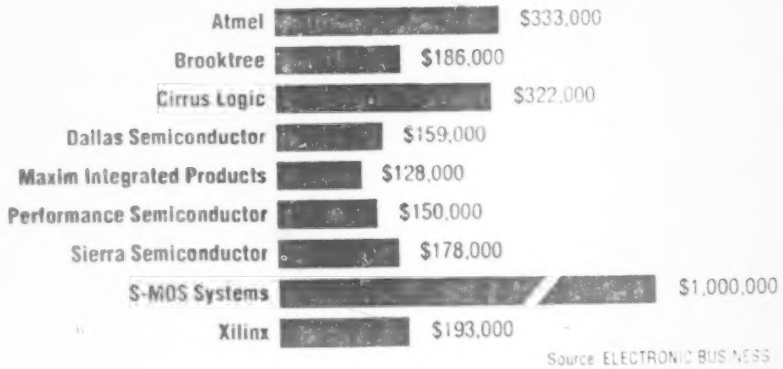


* ELECTRONIC BUSINESS estimate

Source: Dataquest Inc

Upstarts' 1988 revenue per employee

1988 calendar year sales/average number of employees in 1988



Source: ELECTRONIC BUSINESS

The importance of shortened cycle times cannot be underestimated. For small companies, time to market is everything. And when the market is a niche — often tasty market opportunities for larger companies — time to market is even more critical.

Niches: the lifeblood

Niches are the lifeblood for these start-ups. But picking the right niche can be crucial to a start-up's success. It is common for start-ups to zero in on markets too small for large American or Japanese companies to care about. Often, though, niches become trendy, bringing in fast and furious competition.

The hard disk drive market is one example of a sizable niche that went undetected by big companies. In 1989, that market will ship more than21 million units, all of them containing a drive controller, valued at $24 billion, projects market research firm Disk/Trend Inc.

"It was the first market we targeted because it has a large demand and the customers are entreprenuerial themselves," says Cirrus Logic's Hackworth, whose firm sold $29 million worth of chips last year. That figure is expected to double in 1989. And, perhaps, Hackworth has an even more narrow niche in mind. "We only call on customers we can ride our bikes to or drive to," he jests. Luckily for Hackworth, most of his customers are in his Silicon Valley backyard.

S-MOS Systems is staying in its backyard, too, giving niche marketing a new twist. On the face of it, S-MOS Systems' target market of SRAMs looks like anything but a niche, but the San Jose company is "chartered to sell to only the United States and Canada," says president Dan Hauer. "That's the type of company we are. We are focused solely on the region we are in."

Because S-MOS Systems is focused, "we can do a better job serving our customers," Hauer explains. He notes that the company had sales of $96 million last year, making it the sixth largest supplier of SRAMs worldwide. Because S-MOS Systems is 58% owned by Seiko Epson Corp., the Japanese giant handles both the foundry and the sales in Japan. A separate company has been established by Seiko Epson to sell S-MOS technology to the European market.

Nine new mavericks at a glance

Company/ location	Top executive	Calendar year 1988 revenue ($ millions)	Key products	Ownership (founded)/ Original funding	Current number of employees
Atmel San Jose, Calif.	George Perlegos	$60	EPROMs, EEPROMs	Private (Dec. 1984) Private investments	928*
Brooktree San Diego, Calif.	James Bixby	44	High-performance data conversion devices	Private (May 1983) Private investments	305
Cirrus Logic Milpitas, Calif.	Michael Hackworth	29	Mass storage/communications/ graphics controllers	Public (Nov. 1984) Venture captial	206
Dallas Semiconductor Dallas, Texas	Vin Prothro	58	Low-power CMOS memory, microcontroller circuits	Public (Feb. 1984) Venture capital	600
Maxim Integrated Products Sunnyvale, Calif.	John F. Gifford	36	CMOS/bipolar analog	Public (May 1983) Venture capital	386
Performance Semiconductor Sunnyvale, Calif.	Thomas A. Longo	30	High-speed SRAMs, RISC MPUs, logic devices	Private (Oct. 1984) Venture capital	375
Sierra Semiconductor San Jose, Calif.	James Diller	49	Mixed-signal ASICs, standard products	Private (Nov. 1983) Venture capital	310
S-MOS Systems San Jose, Calif.	Dan Hauer	96	ASICs, SRAMs	Private (Nov. 1983) Private investments	147
Xilinx San Jose, Calif.	Bernard Vonderschmitt	27	User programmable gate arrays	Private (Feb. 1984) Venture capital	180

* Atmel acquired three fab facilities from Honeywell July 1989

Source: ELECTRONIC BUSINESS

Besides a clearly defined market focus, much of the success of the nine new-era semiconductor companies can be attributed to alliances, those strong relationships with big players who can provide financing and manufacturing assistance. Sierra Semiconductor, whose founders left National Semiconductor Corp. to establish the company, has managed to maintain a solid rapport with the chip giant, a unique feat in an industry in which many breakaway start-ups end up in court for patent infringement.

"We've joint-developed products and lease a [$30 million] clean room in Singapore from National," says Sierra president and CEO James V. Diller, an industry veteran who worked at National from 1969 to 1983. Sierra's sales last year reached $49 million. "We have all the benefits of a fab without the costs associated with it," he says.

Lack of manufacturing

Since five of the nine companies — Brooktree, Cirrus Logic, Maxim, S-MOS and Xilinx — have no fabrication facilities of their own, they also have had to fight a certain amount of prejudice against their status as nonmanufacturers. Here again, alliances, with several, preferably large, companies can mean the difference to a sale.

When Brooktree discovered a quality problem at one of its seven outside fabs, its multiple foundry strategy paid off. "Having foundries allowed us to switch production to another fab while we fixed the problem at the one fab," says Brooktree president James Bixby.

Flexibility is the strongest incentive for working with foundries

And all of the start-up executives, along with some of their customers, agree that such flexibility is the strongest incentive for working with foundries. But alliances are important as a means of financing as well. S-MOS Systems, for example, has the Hattori family, owners of Seiko Epson, as private investors.

Relationships do not always have to be with a large, established company to be effective. Performance Semiconductor's alliance with the very young and very successful Mips Computer Systems Inc., a leader in the RISC technology race, has been important to the start-up's success. According to Longo, Mips' RISC microprocessors will account for nearly $8 million in Performance Semiconductor's sales this year and as much as $20 million in 1990.

Performance Semiconductor also recently finalized a deal with DEC for an $8 million microprocessor contract that was won, in part, because of his company's "good relationship with Mips," says Longo.

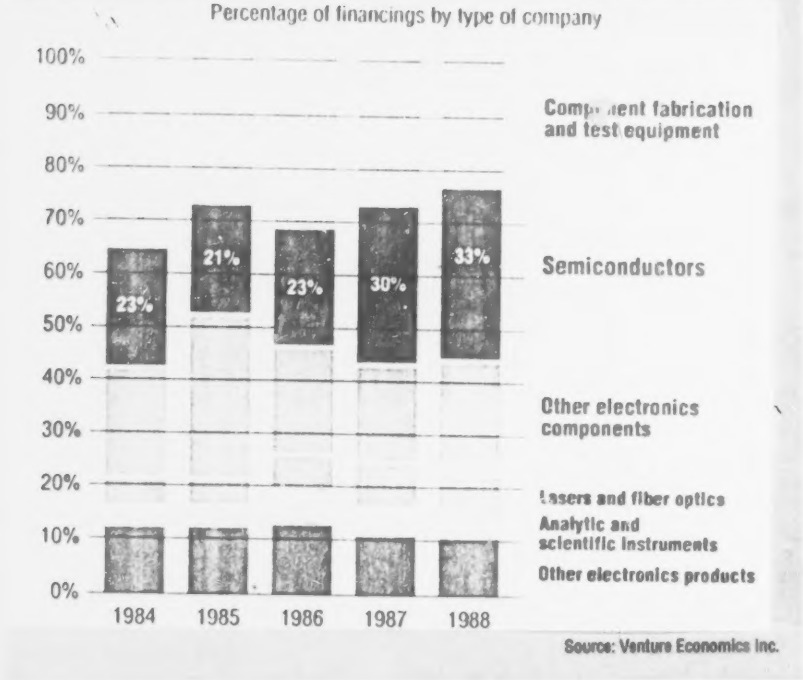
Customers also want alliance-type relationships with their semiconductor vendors. Disk drive vendor Conner Peripherals Inc. works closely with Cirrus Logic because it offers a unique chip "we can't get anywhere else," says Bill Schroeder, Conner vice chairman and president of the new-products group. "Our strategy," notes Schroeder, "is to pick a core vendor and work with it as a system. We make our vendors our partners."

Breaking the rules

"Daring" is an appropriate description for these nine newcomers, content to break rules in a way their predecessors never thought possible. "One of the standard semiconductor rules we broke was to enter the military market early on," says Atmel president George Perlegos. Generally speaking, analysts say, small companies are seen as too weak to support the quality and reliablity demands placed on them by the military. But by focusing on documentation, standards and tight relations with customers right away, Atmel overcame the tough military barriers, making it a $60 million company last year. The company recently completed the purchase of three fab facilities located in Colorado Springs from Honeywell Inc. for an undisclosed amount.

Performance Semiconductor also entered the military sector early on with its microprocessor chips. Longo says his company had no problem securing military business — "mostly because I was known in that area due to my experience at [Fairchild]." Serving more than 100 military companies, that market accounts for 25% of Performance's $30 million business last year.

Venture capital financing for electronics companies



Source: Venture Economics Inc.

Maxim's Gifford also defied traditional semiconductor wisdom when he wrote up a simple three-page business plan proposing an ambitious strategy of developing 15 to 20 new products each quarter. "That was unheard of then," he says. Based on Gifford's semiconductor and start-up experience, investors thought his "slam-dunk" plan was a sound one. And Maxim has kept to that plan, creating about 67 new linear products each year.

Brooktree's founders broke the most cardinal rule of all — no previous semiconductor experience. Bixby was director of engineering at Spin Physics-Eastman Kodak Co., a magnetic recording head manufacturer, but that lack of a semiconductor background has not deterred him as his company reached $44 million in sales last year. "You have to really believe you can succeed," he says with the fervor of an evangelist.

This early success notwithstanding, there remain many challenges ahead for these nine start-ups. Success only serves to render them more visible in the marketplace, bringing increased competition, often from large American and Japanese companies, as well as litigation.

Cirrus Logic, for example, garners stringent competition today in drive controllers from such companies as Adaptec Inc. and International Microelectronic Products Inc. Hackworth's solution is to not license his technology to anyone, using, like Intel Corp., a sole-source strategy. Maxim, meanwhile, which carved out a niche in high-performance CMOS analog, has a unique view on protecting its market: "We're kind of like a porcupine," explains Gifford, "there's no place to grab."

"The only thing you can do is do everything you can to protect yourself," stresses Xilinx president Bernard Vonderschmitt of his $26.5 million business in 1988. "Intellectual property protection is important. You have to try to make it extremely difficult for computers by building as many walls as you can." Xilinx was sued three months after its funding in a suit brought by Zilog Inc. in Campbell, Calif., concerning misappropriation of intellectual property. That suit was settled out of court for less than $100,000, says Vonderschmitt. Today, Xilinx budgets from $200,000 to $250,000 each year for patent searches and preparing patent disclosures, says Vonderschmitt.

The leaders of these start-ups are experienced, street-smart executives savvy to the realities of the semiconductor business

Lawsuits are common risks shared by all of these high-tech companies. Atmel is involved in three suits brought against it, all concerning intellectual property rights, including one with chip giant Intel, according to marketing vice president B. Jeffrey Katz. While he won't reveal the costs of fighting those suits, Katz nonetheless calls the expense "substantial." Says Katz: "The more successful you are, the more attention you attract," adding that attention often results in patents being challenged.

Facing the future

As these companies face the new decade, competitive challenges will only increase. Perhaps the biggest worry is determining how quickly or slowly to allow the company to grow. Most of these companies have lofty ambitions — and business plans to match. The words "billion-dollar company" fall trippingly from the tongues of many of these executives. But making sure that the next two years are as successful as the last two can't be done just with ambition.

As companies grow, the focus, drive and energy that makes them successful tends to fade, notes Maxim's Gifford. The biggest risk is that management pulls away from employees, creating a gap between the hands-on producers and the company's visionaries. "If you can no longer be one of [the employees], you lose something," he says. "That's one problem there is no solution to." □

Semiconductor start-ups cautiously stalk the stock market

The volatile rise and fall of high-technology fortunes on Wall Street is only too familiar to today's semiconductor start-ups.

The nine semiconductor start-ups selected by ELECTRONIC BUSINESS were witnesses to the worst stock market plummet since the Great Depression. A few could have easily been casualties of a poorly timed public stock offering.

As a result, many of these chip executives are moving forward on initial public offerings, but with extreme caution.

These executives are continuing to reap the rewards of being private, while waiting for stronger market conditions to optimize investor return.

"We took a serious run at it at the end of 1988, but then technology stocks took a slide," says president James Bixby of Brooktree Corp. "So we stopped, backed up and asked, 'Why are we doing this?'" Advantages to remaining privately held include keeping sales and profit numbers under wraps and being able to maintain a more long-term market focus.

Going public

According to Bixby: "Once you go public, you get a lot of pressure from analysts and investors to keep earnings up [from quarter to quarter]."

Even Michael Hackworth, president and CEO of Cirrus Logic Inc., which went public in June, admits it was a tough decision on how to time the offering.

Yet Cirrus Logic's transition into the public sector has been successful, its stock selling an average of $2 over the initial $10 asking price. Besides making his customers and investors more comfortable by going public, Hackworth says the biggest advantage has been the increased visibility his company has received.

JOHN McCREADIE

Where are they now: 1987's superstars revisited

Two years ago, 10 start-up companies began to change the way semiconductor business was done. Their challenge now is to keep their entrepreneurial flames burning

BY VALERIE RICE

Two years ago, 10 aggressive start-up semiconductor companies planned to change the way the semiconductor business works — or die trying.

These 10 Silicon Valley firms were content to throw traditional chip wisdom to the wind: they focused on niche markets, in some cases didn't build fabs and vowed to control their costs [ELECTRONIC BUSINESS, Aug. 15, 1987]. A revisit in 1989 shows that these companies' unconventional strategies are reaping dividends.

The 10 companies — Adaptec Inc., Altera Corp., California Micro Devices Corp., Catalyst Semiconductor Inc., Chips and Technologies Inc., Cypress Semiconductor Corp., Linear Technology Corp., Orbit Semiconductor Inc., Vitelic Corp. and Weitek Corp. — all are currently profitable, growing fast and, in many cases, leaders in their fields.

Consider some impressive accomplishments already attained by several of the newcomers: Chips and Technologies, Adaptec, Cypress Semiconductor, CMD and Linear Technology all placed among the 100 fastest-growing California companies in 1988, according to *California Business* magazine; Cypress and Orbit were rated among the 10 fastest-growing IC companies in 1988 by Integrated Circuit Engineering Corp.; Chips and Technologies, Altera and Cypress consistently rank among the top five public semiconductor companies in net profits and gross margins, according to Montgomery Securities; and Chips and Technologies is No. 192 on this year's ELECTRONIC BUSINESS 200 listing of U.S. electronics companies.

In terms of standard industry indices, the ELECTRONIC BUSINESS superstars of 1987 still are outpacing well-established chip companies. Cypress leads the pack by spending 25% of sales on R&D, while the other nine average a solid 15%. Meanwhile, for 1988, the industry at large invested a paltry 11% on R&D, according to the Semiconductor Industry Association. And gross margins for these upstarts, taking into account the dramatically different product areas, are generally higher than average; at such companies as Altera, margins are as high as 60%. Revenue per employee ranges from $90,000 to more than $200,000. Chips and Technologies' revenue-per-employee average, according to the firm, was about $525,000 in fiscal 1988.

If nothing else, these 10 companies can call themselves trend setters, credited with changing the way Wall Street views semiconductor firms. This "auspicious group" of 10, as one analyst calls them, has made it easier for the next round of hot start-ups to find funding, go public and find a sympathetic purchasing ear in large companies. They have also made being fabless chic.

But now these one-time rebels are growing up — facing a future that for the first time includes competition in high-profile markets such as microprocessors and the challenges inherent in managing fast growth. Success has had its price, though. Many of these companies are tempting targets for intellectual property litigation, and several have been sued by larger companies. Their future, certainly, is contingent on how well they navigate such territory.

Growing up fast

Growing fast has other perils, too. What keeps Cypress Semiconductor's flamboyant founder and president T.J. Rodgers up at night? It is the fear his company will go the way of Advanced Micro Devices Inc., a promising 1960s start-up, says Rodgers, but a poor performer as a mature company. "I don't want to see Cypress following a death curve," he stresses.

Rodgers' statement rings true for his fellow executives at the other nine companies, who worry that the firms they built on a departure from traditional semiconductor wisdom will wither as they move into the next phase of growth. There is only one solution: "We're sticking to our knitting," says Linear Technology president Robert Swanson.

Adds Adaptec's president John G. Adler, "We are not a start-up anymore, but we have to continue to foster that kind of impatience. We have to be result oriented." Adler gives a lot of the credit for the company's success to his management team. "I know we have a seasoned management team," he jokes. "We all have gray hair."

At Weitek, president Arthur Collmeyer is managing his operation by creating small business units, respon-

The top executives of the revisited 1987 semiconductor start-ups are, bottom row, from left to right: Gary Kennedy, Orbit Semiconductor; Gordon Campbell, Chips and Technologies.; Chan Desaigoudar, California Micro Devices; Robert Swanson, Linear Technology; top row, Arthur Collmeyer, Weitek; Rodney Smith, Altera, and John Adler, Adaptec

Christopher Springmann

sible on a profit and loss basis to target, develop and market products. This way, according to Collmeyer, the management stays flat, and the company retains the feel of a start-up without the size constraints of a start-up.

But Weitek has an advantage that makes managing the company easy. It has a leader who does not want to run a large company. In fact, Collmeyer says he does not want to develop products that will turn into high-volume sellers. Nonetheless, Weitek grows: The company had $35.2 million in sales last year and is projected by semiconductor analysts to grow to about $60 million by the end of this year.

Rodgers is putting a different twist on an old management strategy — funding subsidiaries to keep employees' interest levels high. "In our first two years, we rolled out 64 products," he explains. "Over the next two years, our product introduction rate was down by a factor of two. In order for us to grow, we had to continue to roll out new products at a fast rate. It is our lifeblood. That's why we have spun off some separate companies, to keep the product innovation going."

Cypress currently has four subsidiaries and is considering funding start-ups "all the time," Rodgers says. In fact, Rodgers has been widely quoted as saying he wants to run a $1 billion company made up of 10 $100 million companies.

With opportunity knocking around every corner, these executives admit it is difficult to limit the number of areas they will explore. With so much opportunity, its easy to diversify too quickly. Yet to stay ahead of much larger competition, it is vital to react quickly.

Chips and Technologies, while still a leader in IBM-compatible chipsets, has diversified into graphics markets, among other areas. And when that market gets too crowded, its founder, president and CEO Gordon Campbell can easily shift from one product area to another. Morgan Stanley and Company Inc. analyst Andrew Kessler notes that "Chips has done a good job hopping from one area to another when the barriers

go down. They're in a good position. They are a model company for no-cost no-fab production."

Although Chips and Technologies' strategy may combine focus with fluidity, others, such as Altera, are concentrating solely on one area: programmable logic. "We are still highly focused on our original strategy [in our niche]," says Altera's president Rodney Smith. But Altera is no longer alone in that niche. Xilinx Inc., a member of the ELECTRONIC BUSINESS start-up Class of 1989, rates as a tough competitor. But Smith contends his company is staying ahead of the competition. "Last year's revenue of $38 million came from five-year-old technologies and parts," he says. "Last fall, we announced the second-generation architecture, and that is spurring our sales on even faster."

In a word, Smith adds, Altera is "swamped. We can't ship enough parts fast enough to meet our demand."

Linear Technology also is "suffering" from the same overwhelming demand, says president Swanson, who has not deviated from his intention to make his firm "the industry's leading linear market specialist company." Swanson has succeeded so well that he paid "a hell of a lot of taxes in fiscal 1988." The company reached $64.7 million at the end of June 1989 — meaning undoubtedly higher taxes, Swanson moans.

In any case, Linear Technology's only change in strategy was its recent assembly, test and finish operation expansion into Singapore, its offshore venture. "We were the first to recognize that analog is not dying — it's growing," he stresses. "It's gone from a $2 billion market to $8 billion since we started the company, and it's going to keep going." For Swanson, as with most linear companies, the challenge will be to continue to introduce a large number of products. "No one circuit is going to hit a home run. We have to introduce lots and lots of circuits," he says.

Catalyst Semiconductor, meanwhile, has broadened its strategy to include both the automotive and consumer markets, and while president and founder B.K. Marya is somewhat leery, he says it is possible "to have a presence among the skyscrapers." The trick, Marya says, is to make sure the company grows slowly and in a controlled way. "I thought we couldn't get in to automotive and consumer markets, but we've done it," he says proudly.

Adaptec has altered its strategy slightly, refocusing markets away from end users and toward OEMs, says Adler. "We have been in a minefield," he says of his company's disk controller business. "Now we are in a beautiful park." But he adds with a note of caution, "I'm still waiting for a hand grenade."

Today, Adaptec does about 40% of its business in chips, up from one-third of its business two years ago. The real change is that Adler has taken the company into the broader peripheral chip-board market, lessening its dependence on the highly volatile disk drive market.

Cypress has diversified dramatically over the last two years, adding Sun Microsystems Inc.'s Sparc chip to its portfolio, among other products. Although the company has a subsidiary, Ross Technologies, to work on the architecture, it will still be a challenge for Cypress to move strongly into the big-dollar processors market. Alice Leeper of market research firm Dataquest Inc. notes that "Cypress is doing the most exciting leading-edge work on Sparc. It could be very big for them in the future."

Orbit Semiconductor maintained a steady course over the last two years, but president Gary Kennedy feels his 100% chip foundry business still "gets no respect." Kennedy says his $21.5 million in revenue last year entitles him to some kudos. "They never thought a pure service company could make it," he remembers. "We've done it, but it is still hard to be taken seriously when you don't have any products."

Serious contenders

Despite Kennedy's view, these companies are taken seriously and have set the pace for other new start-ups, such as Cirrus Logic Inc. and Maxim Integrated Products, to go public.

"Not until this year has Wall Street accepted the notion that design houses can add value without manufacturing," says Donaldson, Lufkin & Jenrette Securities Corp. analyst Drew Peck. "They are finally seen as real firms. Chips and Technologies has paved the way for other fabless companies."

Despite this sweet validation, some companies are a bit surprised at their success. "We are bigger right now than what I had planned," according to Catalyst Semiconductor's Marya. And old habits die hard. "We are still buying used furniture for our offices. I have a wooden desk now, but it's used. I want to run this company the old-fashioned way. We have nobody to impress but ourselves." □

Upstarts revisited at a glance

Company	Top executive	Calendar year revenue ($ millions) 1988	1986	Key products	Current number of employees
Adaptec	John G. Adler	$61	$52	Disk controllers	570
Altera	Rodney Smith	38	10	PLDs	250
California Micro Devices	Chan Desaigoudar	28	10	Telecom data acquisitions devices	290
Catalyst Semiconductor	B.K. Marya	15	1	EEPROMs, smart card ICs	75
Chips and Technologies	Gordon A. Campbell	180	41	PC chipsets	450
Cypress Semiconductor	T.J. Rodgers	139	16	PLDs, SRAMs, RISC MPUs	1,313
Linear Technology	Robert Swanson	59	28	Linear ICs	535
Orbit Semiconductor	Gary P. Kennedy	19	13	MOS foundry services	108
Vitelic	Alex Au	37	1	High performance DRAMs, SRAMs	220
Weitek	Arthur Collmeyer	35	17	Math processors	185

Source: ELECTRONIC BUSINESS

European ASIC makers seek home-field advantage

The Europeans' superior knowledge of their growing home market may not be enough to catch the front-running Americans and Japanese

BY VALERIE RICE

Lured by a healthy home market for application-specific integrated circuits, European semiconductor manufacturers are mired in a struggle to expand their market share on the continent. But the challenge they face may be too much to withstand, as a host of hostile conditions, including extreme pricing pressures and cutthroat competition from the United States and Japan, present formidable obstacles.

Foreign firms undisputedly claim a hefty portion of Europe's estimated $600 million ASIC market already, causing European manufacturers to try to block further advances by embracing U.S. partnerships, enhancing customer service and playing their home-court advantage.

Yet that strategy may fall short. The Europeans are doing battle with some of the biggest global players from both the United States and Japan; they are not primed to win. While the Europeans have superior knowledge of their territory, they are sorely disadvantaged by their sluggish start in the ASIC market.

U.S. and Japanese companies are way ahead. LSI Logic U.K. alone claims to have a 20% share of the European market, mirroring Milpitas, California-based parent LSI Logic Corp.'s worldwide strength. And even while Europe's biggest chip makers — N.V. Philips GL, Siemens AG and SGS-Thomson Microelectronics — struggle with the ASIC market, smaller U.S. firms are already learning to compete. As with the U.S. market for ASICs, the European market is cutthroat, competitive and underpriced.

Yet, because the European ASIC market is growing at a healthy rate, the stakes for all players are high. Gate arrays are expected to be worth $388 million this year. By 1992, however, the market will almost double in size to $726 million, predicts San Jose-based market research firm Dataquest Inc. Cell-based ICs will account for $188 million this year, but that is projected to more than double to $416 million by 1992. Programmable logic devices will sign in at $155, growing by $60 million over the next three years to $215 million, estimates say.

While it is evident that Europeans do not dominate their home ASIC market, precise market share figures are difficult to determine, analysts say. Market research manager William J. McLean of Integrated Circuit Engineering Corp. asserts that "none of the Europeans are in the top 10 suppliers of ASICs worldwide."

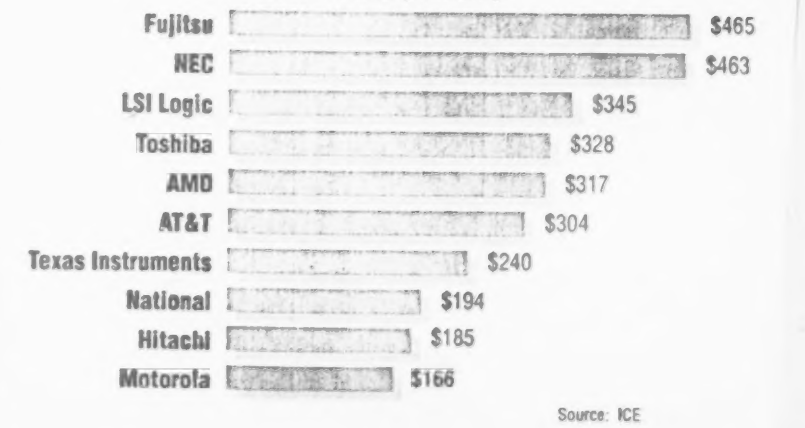
The reasons are telling: European companies lack the competitive pricing, cutting-edge technology and savvy marketing skills of their rivals from the United States and Japan. "In ASICs, European companies are just not competitive," declares Juergen Laumann, electronic/electromechanical purchasing manager of West German computer giant Nixdorf AG.

Despite a stated bias toward European manufacturers, Laumann is frustrated with his compatriots' chip offerings. He is forced to go to American or Japanese suppliers for lower prices, but most often for their superior technology.

Although their operations are structured much like Japanese companies with much the same overhead and internal needs, European firms were poised to be the first to supply the new ASIC technology to their customers. But instead, LSI Logic beat them to the punch in setting up shop on the Europeans' home turf. European companies, such as Germany's Siemens, did not enter the merchant market until last year.

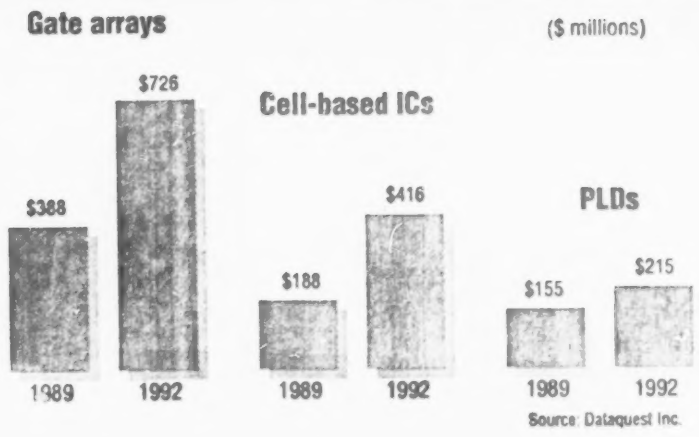
Europe chip makers have limited their own access to important markets because of their slow product in-

Worldwide 1988 top ASIC suppliers



Source: ICE

The Western European market for ASICs



Source: Dataquest Inc.

troductions. "Timing is critical," stresses Siemens' ASIC strategic marketing manager Hans-Peter Bette. "We have to introduce the products at the right time for us to support them. We have to be competitive with the external marketplace."

But that marketplace is way ahead of Siemens today. Admits Bette: "You can never be too early." Through partnerships, though, Siemens is trying to make up for lost time. It recently extended a deal to Toshiba Corp. for standard cells into the gate array arena. And Philips, based in The Netherlands, also has an agreement with San Jose-based VLSI Technology Inc. to second source its standard cell family.

Although SGS-Thomson is investing heavily in ASICs, "We are not so deep into semicustom as American companies are," says Giuseppe Zocchi, executive vice president for research and development in Agrate, Italy. "It is a big priority for us to get more heavily into semicustom," he says, "and it is one thing we don't have to buy from the Japanese."

Deal making and new investment by European firms, however, might be stymied by currently depressed prices for run-of-the-mill ASICs in Europe. The Japanese, for one, are putting heavy pressure on prices, and the Europeans can't cope with severe price cuts.

Philips Components managing director Heinrich Hagmeister notes that there is tough price competition in Europe today, especially at the initial nonrecurring expenses (NRE) level, where about half the costs are taken up in design. "There is one problem with charging for the NRE," he says. "You can't get your cost. The Japanese are very aggressive, so one result is that customers sometimes expect too much. If the business doesn't make money, that is the wrong approach."

One way the Europeans are fighting back is by giving European customers two benefits the Japanese can't yet match: superior customer service and local manufacturing. The general consensus among market watchers and executives is that most Japanese companies have targeted Europe as their next manufacturing site, and the European advantage may soon disappear.

The Europeans are sorely disadvantaged by their sluggish start in the ASIC market

In the meantime, there is discussion in the European chip community of setting fair market value pricing on ASICs, particularly gate arrays. That move could slow declining prices, but Europeans are skeptical of the measure. "It took us four years to reach an agreement on values for DRAMs," says one semiconductor executive. "Now that we have, there is a shortage and prices are high. I can't afford to wait another four years for an ASIC agreement."

But U.S. ASIC vendors in Europe are suffering pressure from the Japanese as well. "The Japanese want to get market share here," says VLSI Technology GmbH's Dieter Metzger, based in Munich, West Germany. But he claims that the "Japanese are even more agressive in Europe [than they are in the U.S.]." Adds Stephen Forte, president of Sierra Semiconductor B.V. in The Netherlands: "The Japanese have picked here as a battleground; they are going to kill everyone."

But the impression that the Japanese are going to steamroll the competition in Europe may not be entirely accurate. Doing business across Europe is complex, and that alone has slowed market growth not only for Europeans, but Americans and Japanese alike.

Perhaps the biggest impediment to the spread of ASICs is a small user community, according to Forte. "We need bigger users to drive the technology," he says. That may be true. The key technology driver in the United States is the computer industry, which in Europe contributes only a modest portion of the total market for ASICs. In Europe, the telecommunications market is far larger than the computer industry as well as a key technology driver.

The European market has other idiosyncracies. "We find in Europe applications and customers that are as advanced as anywhere else in the world," says LSI's Thomas. But the Europeans have an unshakable reputation for being talkers — then not following up. "One of the unfortunate aspects of the European market is that there are a lot of grandiose plans for tomorrow or the day after," Thomas adds.

Perhaps the toughest barrier to the European market are the country-to-country rules that plague the sale of ASICs — and most anything else in Europe. Many of the troublesome regulations should disappear when the walls come down and a single market is created in 1992.

Despite the inherent difficulties in selling ASICs in Europe, few European manufacturers are shying away. Philips' Hagmeister explains: "ASICs are a necessity, a fact of life. We have been in the ASICs market, we will be in the ASICs market — no matter what." □

Board makers fight for profits as growth slows

As capital equipment costs squeeze vendors, sluggish sales are forecast. Buyers are demanding higher density packaging, improved quality and faster turnaround

BY ROBERT HAAVIND

Despite healthy growth in the U.S. printed wiring board industry — up 17% in 1988 to $5.5 billion — profits have been scarce. For 1989, analysts forecast only slight single-digit growth.

Electronic equipment makers are pressing for higher density packaging with more board layers, often based on surface-mount or other advanced technologies — while at the same time demanding higher quality and faster turnaround to meet the needs of just-in-time production systems. Buying on price alone is also fading, vendors agree, as the big customers seek partnerships with suppliers.

Offsetting the single-digit growth projections, however, is market growth resulting from the shift away from in-house production by systems firms. This is attributed mainly to the high cost of specialized equipment. Captive production has dropped from more than 51% in 1980 to about 38% in 1988, says James Griffin, director for marketing programs at printed circuit board manufacturer Hadco Corp. of Salem, N.H. Griffin says Northern Telecom Ltd.'s recent decision to shut down a PCB facility in Canada is indicative of this trend.

To meet stepped-up requirements, independent manufacturers have been forced to invest heavily in new capital equipment, which has eroded profits. Some of them have been forced to sell off or close some of their less efficient shops as well.

Competition remains fierce in this fractionated market, with the top 10 independents getting only about 25% of the noncaptive business, according to Harvey Miller, president of K-MA Marketbase Services, Palo Alto, Calif. Hundreds of vendors, down to small prototyping shops, along with captive firms such as Tektronix Inc. that do some outside work, get the rest of the merchant market.

Many PCB manufacturers are narrowing their focus, in both products offered and industries served. Meanwhile, many outdated shops are being shut down. Tyco Laboratories, for example, recently closed a two-sided board shop. With growth tapering off in the second half of this year as the computer business slows down, the going is expected to get even tougher.

Market growth for rigid PCBs will drop to 2% to 3% this year after its 17% growth in 1988, according to Bill Loeb of Wm. E. Loeb & Associates, Soquel, Calif., who, together with Henderson Ventures, publishes the newsletter *PCI Report*. Loeb believes that this splintered market of small, often privately held firms, with high capital requirements, may present a tantalizing target to much better capitalized Japanese companies.

Captive PCB production has dropped from 51% to 38% between 1980 and 1988

Loeb points out that the Japanese market reached $5.4 billion in 1988, and should exceed sales in the U.S. market in 1990. CMK, the largest Japanese independent producer, is already establishing a plant to print and etch single-sided boards in San Diego, reportedly to serve Japanese auto and consumer electronics plants in the United States. But since CMK's 1989 sales are estimated at $400 million — over double the largest U.S. independent, Hadco's $157 million — CMK could become a formidable competitor in the U.S. marketplace, Loeb suggests.

Still, the need for closer liaison between systems firms and board makers, coupled with exchange rate pressures, is bringing more printed wiring board fabrication back to the United States. Seagate Technology Inc. of Scotts Valley, Calif., among others, recently moved some board fabrication back onshore from the Far East, according to Jon Kropper, Hadco president and CEO. The trend is toward more North American production, including Canada and Mexico, points out K-MA's Miller.

Hadco's Kropper says factors helping the U.S. PCB business are increased orders for smaller lots of more specialized boards, JIT systems, and the improved service offered by U.S. companies. More automated production raises productivity, particularly for surface-mount boards, and lower labor cost differentials are also helping U.S. vendors.

"Korean wages are now 20 times higher than their 1979 level," Kropper says. He also cites higher wages in Singapore and Taiwan, and exchange rate fluctuations that make Korea and Taiwan less attractive. "But still, American firms must be world class and customer driven to compete," he says.

Clyde Coombs, marketing manager, Printed Circuits Division, Hewlett-Packard Co., and author of the *Printed Circuits Handbook*, shares this sentiment: "There are world-class operations in Korea, Hong Kong, and Taiwan, and you can jump on a plane and be over there in a few hours." However, Coombs emphasizes that these facilities are primarily for very high volume, low-cost production, ideal for consumer products but not for instruments or industrial equipment. The need for local content for overseas

markets drives some of the offshore buying, explains Digital Equipment Corp.'s Duane Napp, high performance system manufacturing engineering manager, Marlborough, Mass. About 80% to 90% of boards with up to four layers are being made offshore, says Napp.

There is a major push for surface mount technology for higher connection density, which provides shorter circuit paths for faster computers. SMT also promises improvements in productivity. Automated SMT equipment lowers assembly costs for volume production, and also increases reliability. Until recently, surface mount components cost more than through-hole packages, and selection was limited. Now, Coombs says, they are roughly equal in cost, more SMT parts are available, and they are expected to become cheaper than through-hole devices.

This trend, as with many other advances in printed wiring technology, came out of the consumer business. Sony Corp. was an early user of SMT, for example, for its Walkman. Reliability is not so critical in consumer items, which provide a testing ground for lower-cost, high-volume fabrication technology. However, failure levels in the early phases of innovative packaging would be unacceptable in computers, says Napp.

Until the mid-1970s, IC chips were the limiting factor in switching speed, but since then, wiring lengths have become critical. More layers as well as denser wiring on each layer help shorten circuit paths, so that today's boards are three or four times denser than those in the mid-70s. With pin-through-hole components, some 60% of the component area is wasted, says Napp.

In the U.S., most boards are now in the five- to seven-layer range, according to David Verbeten, director for product management for Norplex Oak Inc., a subsidiary of Allied-Signal Corp., in La Crosse, Wis., which manufacturers copper-clad laminates. Nine-layer boards are now about 15% of the business, Verbeten says. HP has moved from all through-hole production to more than 50% surface mount for new products in the past five years, according to Coombs, and the trend will continue.

But denser circuitry and surface-mount technology offer new challenges to the industry. Pins through holes added stiffness to a PC board that is lost when components are attached only with solder bumps on the surface. More layers help add stiffness, which is important because flexing could break connections in the via holes.

As big board users look to partnering with suppliers, growing vendors are those offering the latest equipment and extended skills and services. Newer firms such as Apple Computer Inc., Compaq Computer Corp. and Sun Microsystems Inc. see themselves as being in the systems rather than the manufacturing business, and they make none of their own boards, according to Hadco's Kropper. They want their suppliers to help them speed products to market, so board makers such as Hadco are now adding or expanding workstation capabilities for advanced in-board design.

Recent growth in the military end of the market has slowed and is expected to be flat through 1990, says Dale Reed, marketing manager for the Soladyne Division of Rogers Corp., San Diego. The market has reached $200 million for PTFE (polytetrafluorethylene, or Teflon) boards for high reliability, mostly microwave applications. Of the less than 20% of that market available to independents, Soladyne has about 40%, says Reed. After 1990 Reed expects the market to grow again at a 4% to 5% rate.

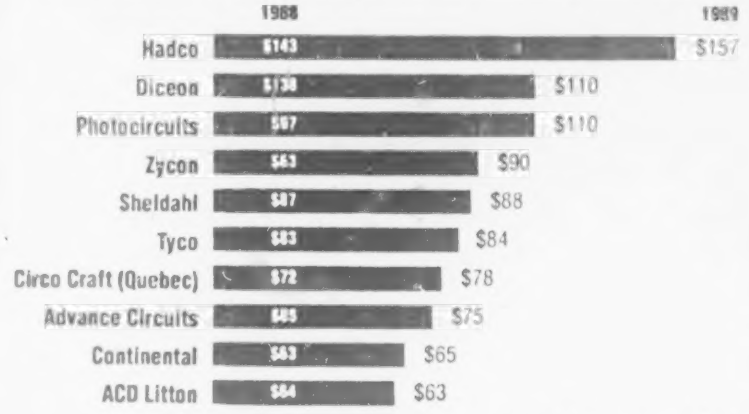
Business is also growing in the Far East. Norplex Oak has gained 45% of the market in Southeast Asia, although only 4% in Japan, according to Verbeten. Although the Japanese share seems small, he says it has doubled each year for the past three years and the company expects significant future growth there. "To succeed in Japan you have to beat their domestic quality levels and have enough capacity to sustain a long-term commitment," he observes.

As factors limiting performance have shifted from chips to interconnections, the industry is pressed to push interconnection capabilities along with semiconductor technology. As chip passivation techniques have improved, several bare chip packaging methods have developed, especially multichip modules (MCMs). IBM launched this concept in the mid-1970s with temperature control modules (TCMs), putting IC chips on ceramic substrates and packaging them with massive cooling structures.

MCM demand will not begin growing rapidly until about 1995, concludes George Messner, senior scientist of PCK Technology, in Melville, N.Y., who has analyzed its potential. Even then, although MCM may grow to be 18% of the total interconnection substrate market, he expects little impact on the conventional printed wiring board business, which he expects to grow worldwide at about 10% a year from $20 billion in 1990 to some $50 billion in the year 2000. □

Top independent North American PCB makers

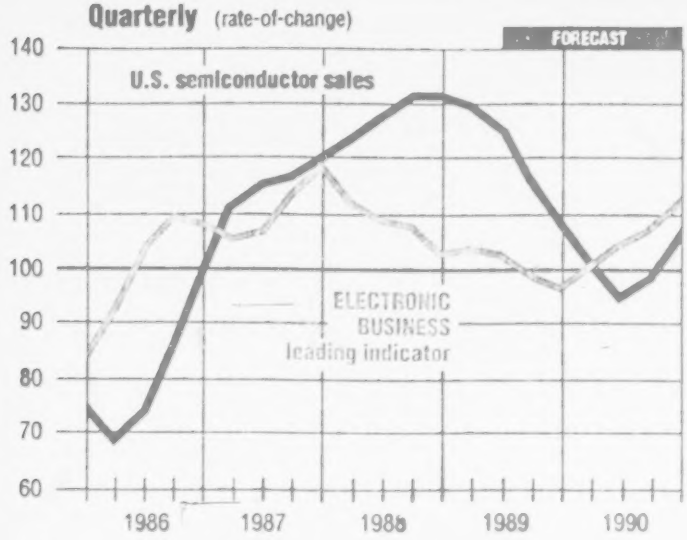
Value of North American PCB production and interconnect value added ($ millions)



Source: K MA Marketbase Services

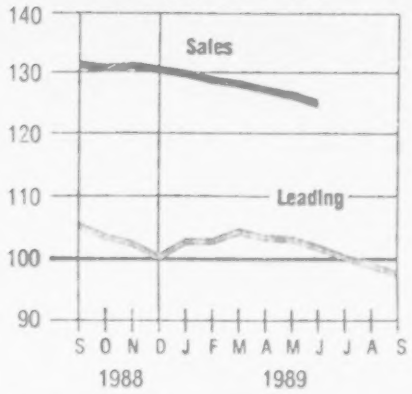
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158, or call (617) 558-4368

Monthly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator dropped to 103.2 in May, down slightly from 103.8 in April. The indicator is expected to reach a low point of 95.7 in October 1989. The bottoming out of the indicator at this level implies that the 1989 slowdown will be much milder than the recession of 1985, when the indicator fell to 80.8 in October 1985.

Source: Cahners Economics

Electronics industry indicators this month

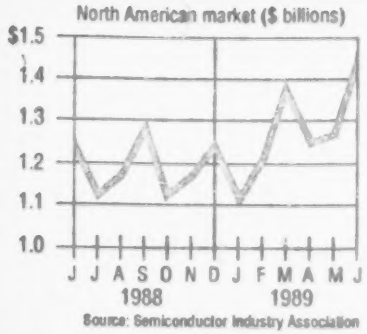
	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, May)	103.2	103.8	108.5	107.6
U.S. semiconductor bookings ($ millions, 3-month average, June)	$1,307	$1,286	$1,287	$1,178
Weekly hours of semiconductor production workers (monthly average, May)	39.4	40.0	40.2	40.2
Electronic components leadtime index (1977 = 100, July)	107.4	120.6	123.2	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, June)	57.6	55.9	64.6	54.5
Change in electronic components inventories ($ millions, SA, May)	+$22	+$16	-$12	+$80
Contracts and orders for plant and equipment ($ billions, SA, May)	$41.6	$44.5	$36.0	$39.4

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

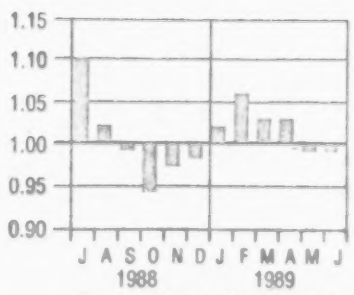
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

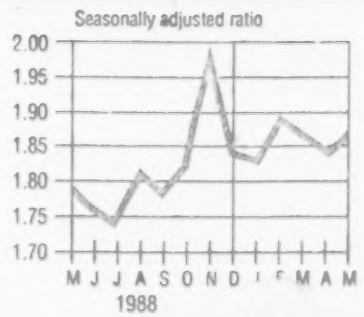
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



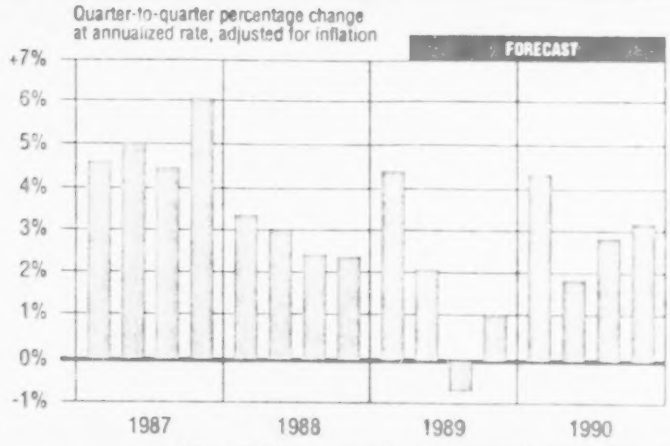
Source: U.S. Comm

Cahners Economics forecasts

Percentage change	February forecast 1989	February forecast 1990	July forecast 1989	July forecast 1990
Real GNP	+2.7%	+1.7%	+2.6%	+1.5%
Consumer price index	+4.7%	+4.7%	+5.1%	+4.7%
Industrial output	+3.3%	+1.7%	+3.2%	+1.4%
Disposable income	+2.6%	+1.7%	+3.4%	+1.6%
Business investment	+4.9%	+2.0%	+4.5%	+2.3%
Pretax profits	+3.1%	+1.6%	+1.1%	+0.5%

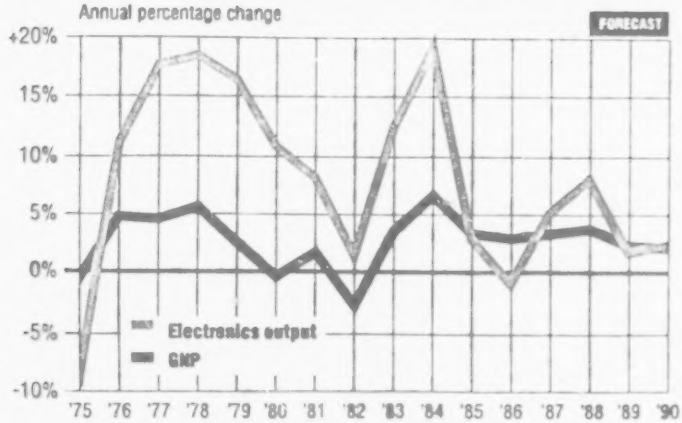
Data source: Cahners Economics

Gross national product



Data source: U.S. Commerce Department; Forecast: Cahners Economics

GNP versus electronics output



Data sources: U.S. Commerce Department, Federal Reserve Board; Forecast: Cahners Economics

Consensus continues: no recession next year

The word *recession* may be more popular these days in the general business press and in arguments among economists, but according to the Blue Chip Economic Indicator, Sedona, Ariz., the consensus of more than 50 economic forecasters continues to predict a soft landing for the economy. Cahners Economics' macroeconomic forecasts — the underpinning for the electronics industry forecasts that are reported in this column every issue — concur. There will be no full-fledged recession in the next year.

The Blue Chip panel predicts the inflation-adjusted gross national product will rise 2.6% in 1989 and 1.5% in 1990, as of the July survey. That consensus forecast is relatively unchanged from the GNP forecast ELECTRONIC BUSINESS reported March 6.

Some doom-and-gloomers in the economic forecasting community remain. Yet optimistic forecasters outweigh the pessimistic ones, so the consensus looks happy.

Interestingly, of all the Blue Chip forecasters, those who work for the banking and security industries are most worried about a recession. These forecasters are predicting a mere 1.4% gain in GNP next year and only a 1% rise in total U.S. industrial output. The group of crystal-ball gazers we classify as economic consultants is a bit more optimistic. This group expects GNP to increase 1.9% and industrial output 1.3% in 1990.

The last group of forecasters, those who work for manufacturing and retailers, is the happiest lot of all. They expect the GNP to increase 1.9%, the same as the consultants, but they also predict industrial output will see a stronger gain of 2.2%.

Cahners Economics' GNP forecasts fall in the latter category of optimism. At 2.4% for 1989, our real GNP growth forecast is eighth from the bottom of the Blue Chip list, ranked top to bottom by strongest to weakest growth. In 1990, our forecast of 2.3% growth places us 10th from the top.

What should you make of all these forecasts? Never fear, whatever business scenario you want to plan for next year, you can probably find a number cruncher to support you. At the very least, electronics companies will continue to take their economic forecasts with a grain of salt. As always, the best will remain prepared for more than one possible economic outcome.

ELIZABETH B. BAATZ

The macroeconomic outlook topic will appear again in March.